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An Isolated HII Region near ESO 481-G017

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Abstract. We obtained VLA 21-cm observations of the galaxy ESO 481-G017 to determine the environment and trigger of remote star formation traced by a HII region found 43 kpc from the galaxy (in projection). ESO 481-G017 is an early type spiral galaxy with a HI mass of 1.1×10^9 $M_\odot$ and a distance of 55 Mpc. The isolated HII region has a Hα luminosity of $10^{38.1}$ erg s^{-1} and minimal continuum emission suggesting that new stars have formed where little or no stars previously existed. The difference in velocity between the HI disk of ESO 481-G017 (3840-4000 km s^{-1}) and the isolated HII region (4701$\pm$80 km s^{-1}) indicates the origin of the HII region may be stars forming in a tidal feature or newly triggered star formation in a very low luminosity companion galaxy. The VLA observations shed light on the nature of this young object.

Introduction

A number of small isolated HII regions have been discovered by their Hα emission in the narrow band images obtained by the NOAO Survey for Ionization in Neutral Gas Galaxies (SINGG; Meurer et al. 2006, Werk et al. 2009). SINGG is a Hα survey of $\sim$500 HI-rich nearby galaxies. Since a gaseous reservoir is a prerequisite for star formation, SINGG measures a broad census of star formation in the local Universe. The isolated HII regions appear as unresolved emission line sources at projected distances up to 50 kpc from the apparent host galaxy and are confirmed with spectroscopy or GALEX data (see Werk et al. 2009). One example of a system with isolated HII regions is NGC 1533 (Ryan-Weber et al. 2004). The HI image of NGC 1533 revealed a large tidal HI ring, consisting of two major arcs (Ryan-Weber et al. 2003), and SINGG Hα images show that one arc contains 5 isolated HII regions. High Resolution Channel (HRC) Hubble Space Telescope (HST) imaging of the stellar population underlying these HII regions indicates they are small, young (2-6 Myrs) stellar clusters with masses $\sim10^4$ $M_\odot$, similar to Galactic OB associations (Werk et al. 2008). Although their star formation rates are small, in situ star formation in the ex-

treme outskirts of galaxies and may be important for the chemical enrichment of halo gas and possibly the intergalactic medium (IGM).

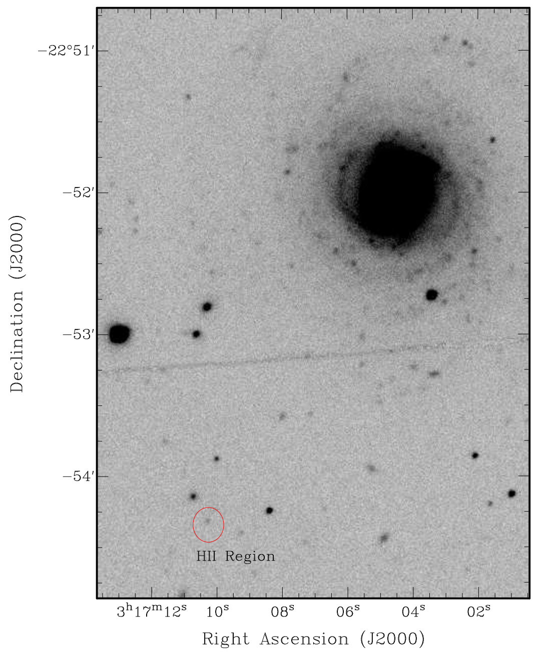

Figure 1. Hα and continuum image of ESO 481-G017 from SINGG. The HII region's location is labeled.

The combination of SINGG imaging and Magellan long-slit spectroscopy has revealed a particularly interesting confirmed isolated HII region in the vicinity of the galaxy ESO 481-G017 (hereafter ESO 481). ESO 481 in an early type spiral galaxy with both a central bar and a ring and a HI mass of 1.1×10^9 M$_\odot$. Magellan optical spectroscopy has detected Hβ, [O III], Hα, [N II] and [S II] from the isolated HII region and the Hα luminosity is $10^{38.1}$ erg s^{-1}. The isolated HII region is about 43 kpc (in projection) from the center of ESO 481 and with virtually no detected continuum emission (see Figure 1). One of the most unusual features of this isolated HII region is its large velocity offset from ESO 481 of $\sim$ 900 km s^{-1}. The spectrum of the HII region reveals that it has a velocity of 4701 $\pm$ 80 km s^{-1}, while the HI spectrum of ESO 481 extends over a velocity range of 3840-4000 km s^{-1}. The large difference in velocity from the main HI disk of the galaxy hints that the isolated HII region may be the result of an interaction. Here we present HI observations of ESO 481 to unravel the origin of the HII region.

Observations

21-cm observations were obtained using the Very Large Array (VLA) Telescope of the National Radio Astronomy Observatory (NRAO). The observations were made with the DnC array configuration ($30''$ (8 kpc) beam at 20cm) at a central velocity of 4300 km s^{-1} with a velocity range from 3660-5000 km s^{-1} and

a spectral line RMS noise level of 0.6 mJy/beam. Data editing, calibration and imaging were completed using AIPS following the standard procedures for spectral-line observations.

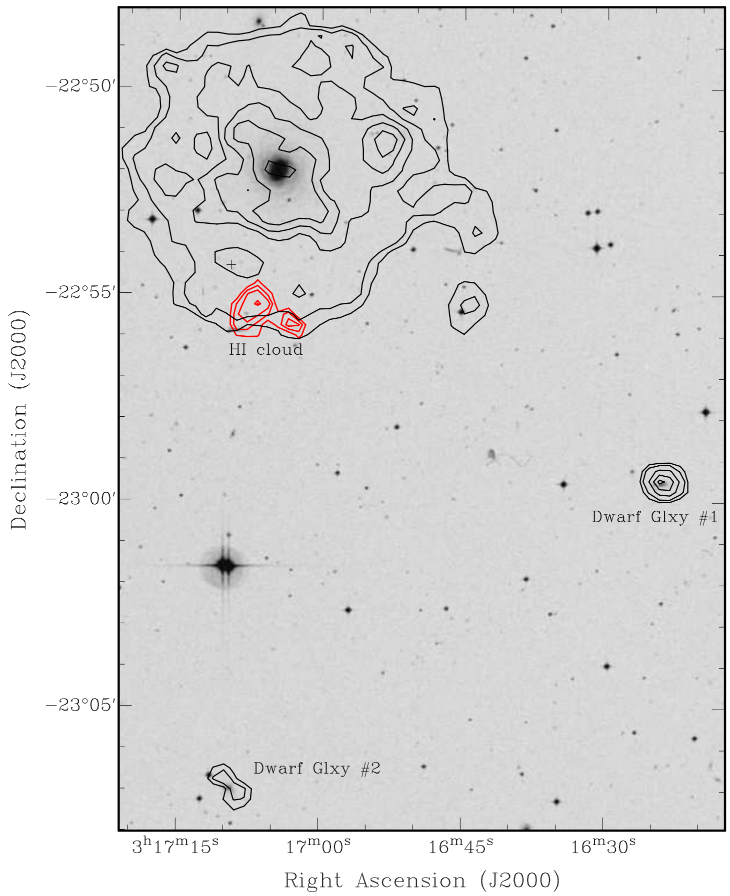

Figure 2. ESO 481-G017 and companions with HI contours overlaid at 0.4, 0.8, 1.5, 2.2, 3.0, 3.7, and 4.1 $\times 10^{20}$ cm^{-2}. The HI cloud is denoted with red (grey) HI contours overlaid at 0.8, 1.6, 2.3, and 3.1 $\times 10^{19}$ cm^{-2} and the HII region's position is denoted with a +. See Table 1 for the positions of the objects.

Results

Figure 2 shows the DSS image plus HI contours of ESO 481 and two new dwarf companions and Table 1 summarizes the detected objects. Although, we did not detect HI gas at the exact position of the isolated HII region (see also Fig. 1), we discovered a new HI cloud only 15 kpc (in projection) from the HII region position at approximately the correct velocity. The HI cloud is over a velocity of 4729-4740 km s^{-1} and has a HI mass of 3.0×10^7 M$_\odot$. If the HI cloud is assumed to be gravitationally bound it has a total mass of 2.3×10^8 M$_\odot$.

Also in Figure 2 it is shown that ESO 481 has a large extended HI disk (∼120 kpc in extent) and forms a small gas-rich group with two dwarf companion galaxies at comparable velocities to ESO 481. The total mass of HI in the group is 1.5×10^9 $M_\odot$, excluding the HI cloud, which may or may not be part of the group. One of the dwarf galaxies has a HI mass of 2.4×10^8 $M_\odot$ and the other one's mass is 1.1×10^8 $M_\odot$, at a velocity range of 4050-4100 km s^{-1} and 4080-4110 km s^{-1} respectively.

Table 1. Properties of ESO 481-G017 and companions

Name	RA[a]	Dec[a]	V km s^{-1}	Distance[b] kpc	HI Mass $M_\odot$	M_{dyn} $M_\odot$
ESO 481-G017	03:17:4.5	-22:52:0.0	3840-4000	-	1.1×10^9	1.6×10^{11}
Dwarf Glxy #1	03:16:24.3	-22:59:29.7	4050-4100	195.0	2.4×10^8	3.3×10^9
Dwarf Glxy #2	03:17:8.8	-23:07:0.0	4080-4110	240.0	1.1×10^8	9.6×10^9
HI Cloud	03:17:6.7	-22:55:30	4729-4740	58.0	3.0×10^7	2.3×10^8
HII Region	03:17:10	-22:54:18	4700±80	43.0	-	-

[a]Approximate central value.
[b]The distances are in projection from the center of ESO 481-G017 which is at 55 Mpc.

Conclusion

We have discovered that ESO 481 is part of a small gas-rich group and that ESO 481 itself has a very large extended HI disk (∼60 kpc in radius). There are two gas-rich dwarf companion galaxies detected and a HI cloud at the velocity of the HII region. The significant offset in the velocity of the HII region and HI cloud compared to the rest of the galaxies (ESO 481 and companions) indicates it is not actually part of the group, but at the outskirts. The offset from the HII region and the HI cloud is mysterious, as well as the trigger of the star formation as traced by the HII region. Is this a low surface brightness galaxy that has recently begun to form stars again? Or possibly some leftover material from a previous interaction with star formation being triggered at the compressed edges of the cloud? Further multi-wavelength data will help to unravel the origin of the HII region and the relation of this system to the ESO 481 gas-rich group.

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